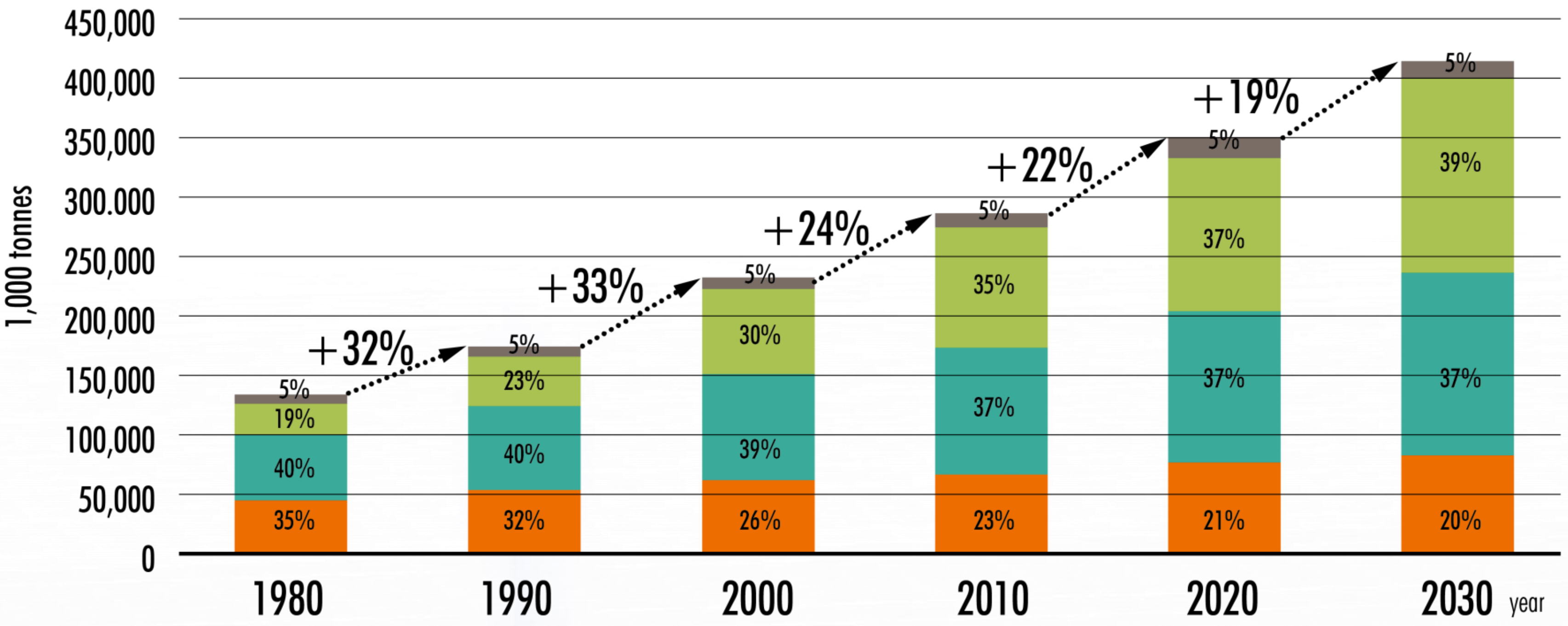
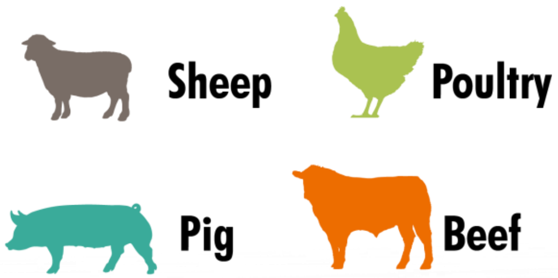
OPTIMIZING FEED STRATEGY FOR EFFICIENT AND SUSTAINABLE POULTRY PRODUCTION

Will Lin, Ph.D.
Research & Technical Director, Alltech China

WHEN PEOPLE CAN CHOOSE, **THEY EAT MORE MEAT!**

GLOBAL MEAT DEMAND GROWTH ESTIMATES 2010-2030





OECD-FAO Agricultural Outlook 2009-2018

Increasing in poultry consumption

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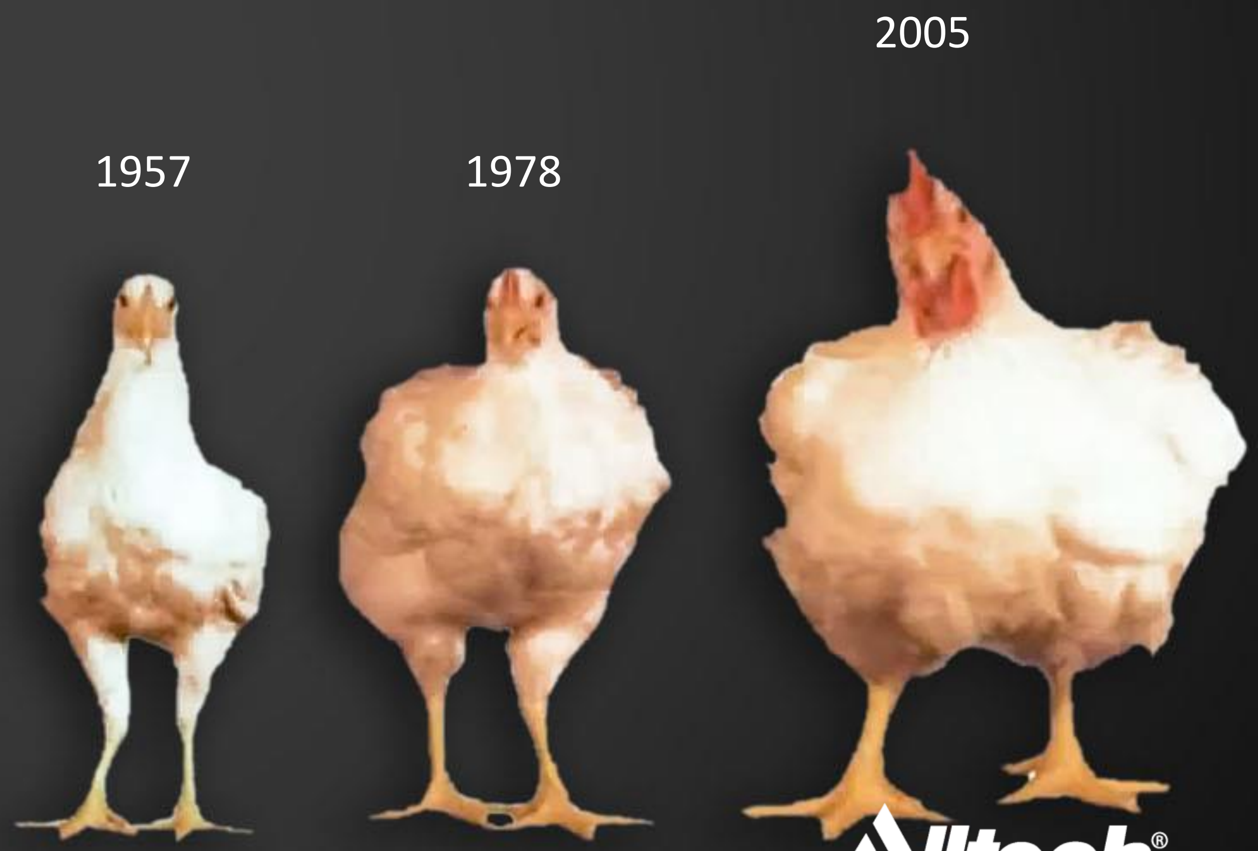
Twice the size in half the time

Year	Average Days to Market	Market Wgt lb, live weight	Average days per pound	Feed to Meat Gain
1925	112	2.5	44.8	4.7
1950	70	3.08	22.7	3
1975	56	3.76	14.9	2.1
2015	48	6.24	7.7	1.89



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Improvement in Broiler Performance:

	2003	2019	2025*
42 d, Live Wt, g	2805	3500	4000
42 d Feed/Gain	1.70	1.74	1.65
Days to 1.8 kg	32	27	23
FCR for 1.8 kg	1.50	1.30	1.10

- >50 g weight/year
- >1% increase/year

Havenstein et al., (2003)
Ross 708 Growth Trial at NCSU, 2019
*Projected Growth Performance

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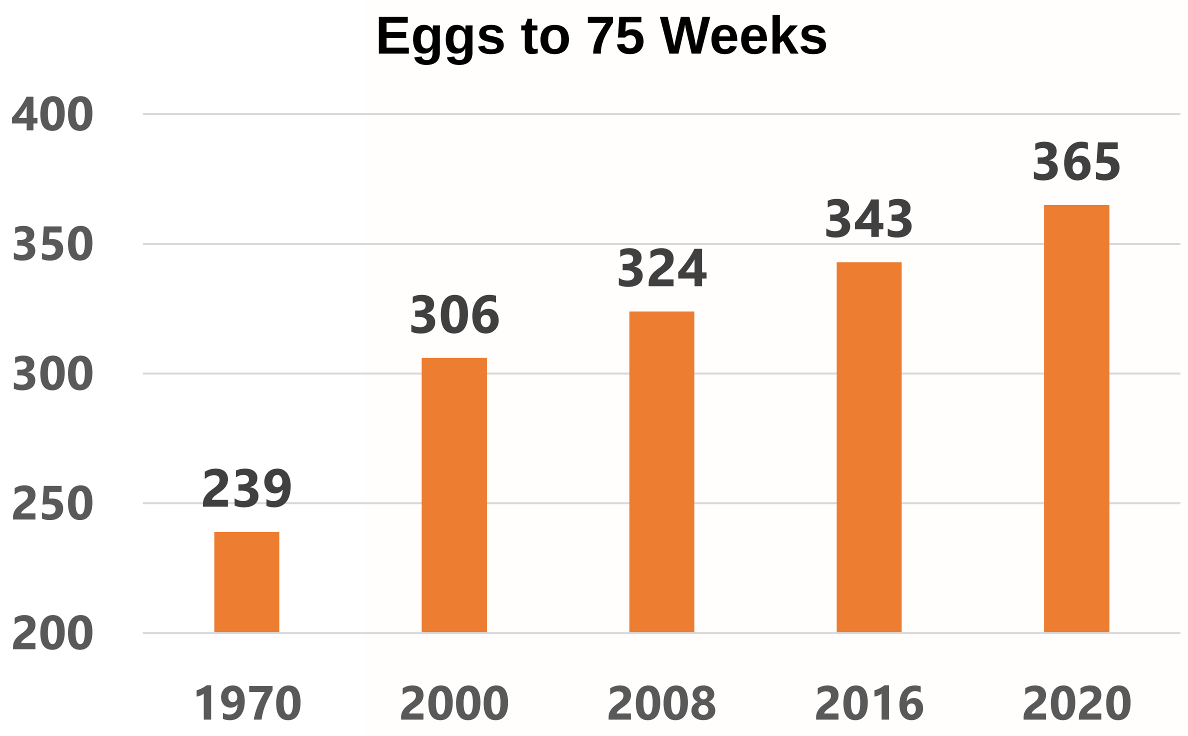
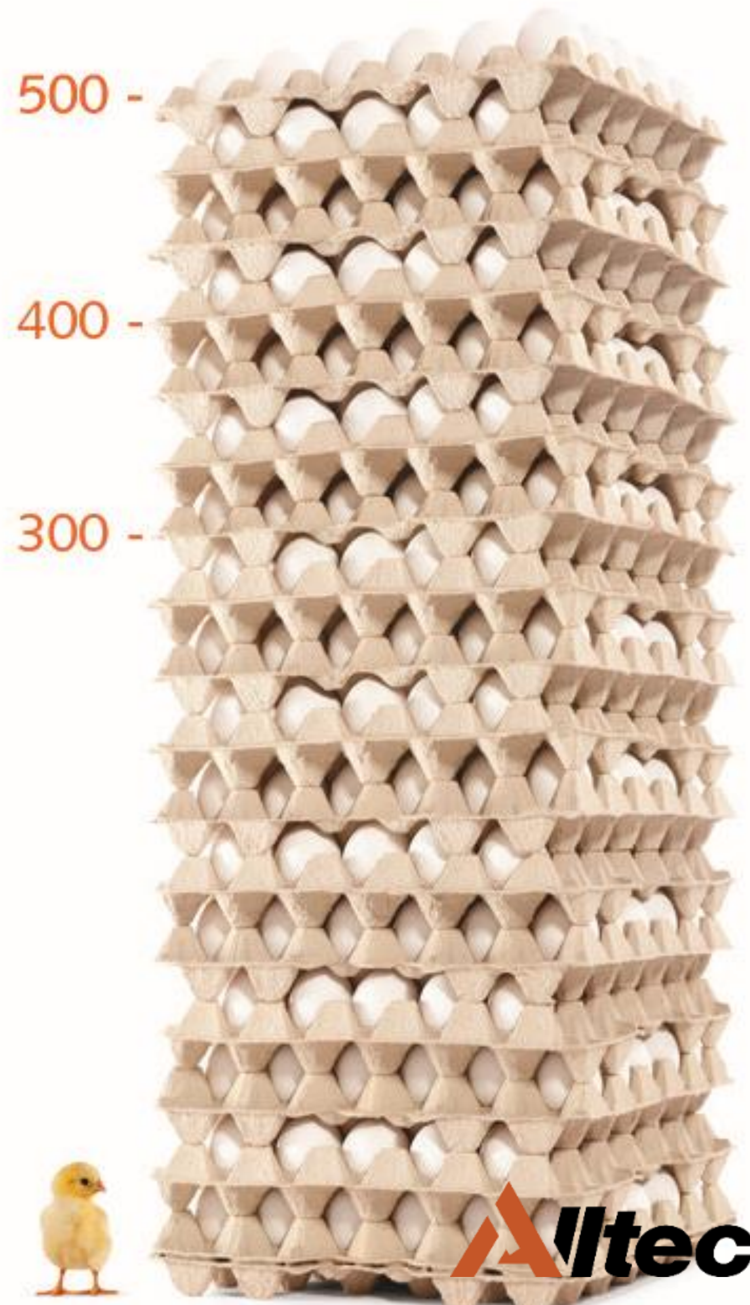
Remarkable changes!





Genetics Changed the Playing Field…

…but Can We Continue on this path and still Produce What Consumers Want?

What Do Consumers Want?

- ✓ Wholesome, safe and affordable food
- ✓ Food that looks good and is enjoyable to eat
- ✓ Acceptable animal welfare
- ✓ Environmental stewardship

We Know What It Takes to Succeed in Modern Poultry Production

- The right genetics
- Optimum health and management
- Optimum nutrition and feed program
- Achieve competitive production indicators
  - Weight for age, ADG, days to market
  - FCR, caloric conversion
  - Livability and flock uniformity
  - Processing yields

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Future Challenges

- ✓ **Demand for poultry products**
  - ➢ Efficacy of production
- ✓ **Regulatory changes**
  - ➢ Pollution and human health concerns
- ✓ Competition for feed resources
  - ➢ Sustainability

www.fao.org

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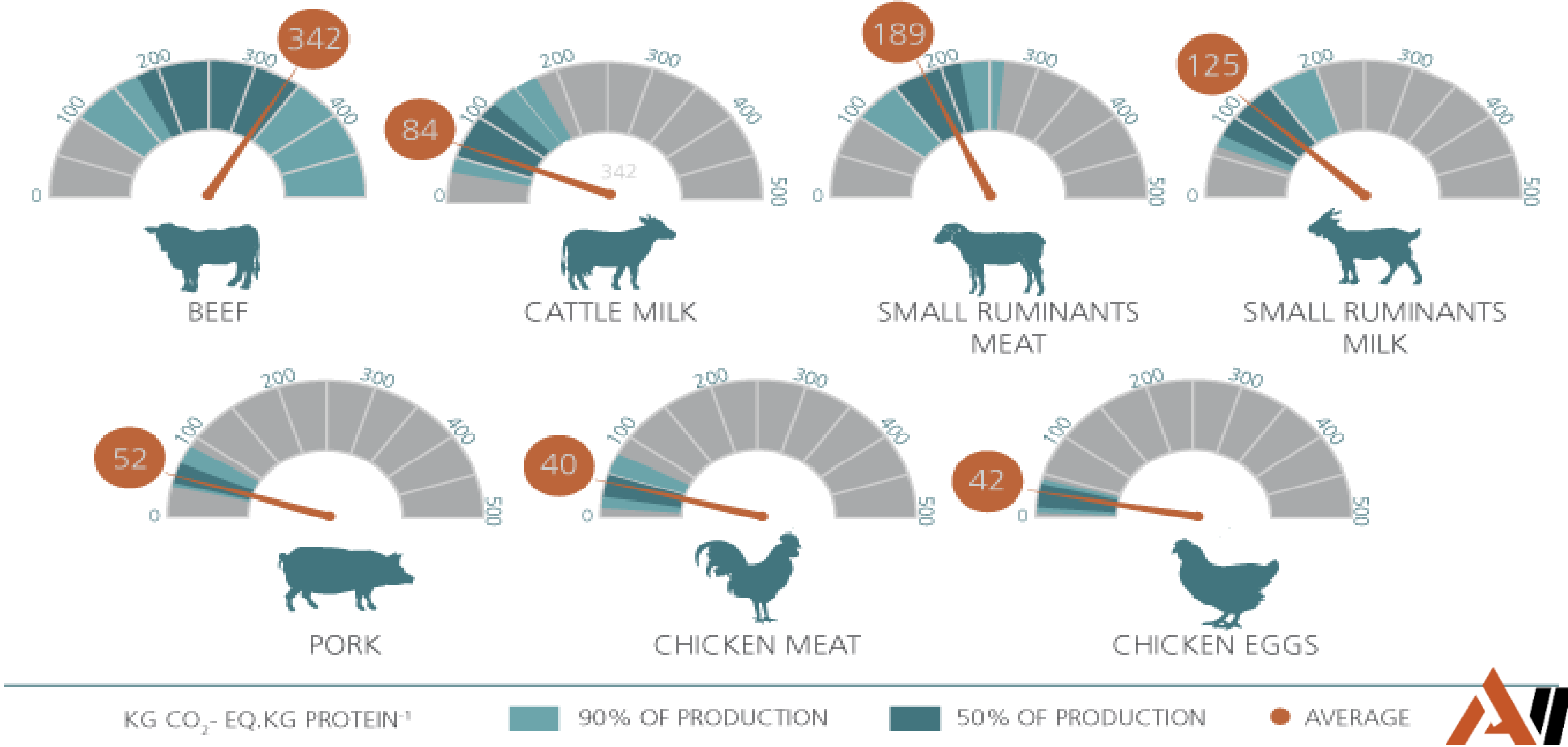
Save the world, eat more chicken and eggs!

CO_2/kg livestock produce



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Environmental
Sustainability
Economic
Social
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Nutrition and Management needs to kept pace with genetics

The time has come to

CLOSE THE GAP with Science and Innovation

Areas to consider….

- ✓ **Diet adjustments**
  - ➢ Improving efficacy & reducing waste
- ✓ **Manufacturing practices**
  - ➢ Testing, precision, new approaches
- ✓ **Scientific advancements**
  - ➢ Alternative feed ingredients, Gut health, Nutrigenomics, equipment, etc.
- ✓ **Alternative programs to meet consumer demands**
  - ➢ Food quality concerns

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NRC Guidelines: Poultry-Chickens

Nutrient	Layer-80[a,b]	Layer-100[a,b]	Layer-120[a,b]	Broiler 0-3 wk	Broiler 3-6 wk	Broiler 6-8 wk
Protein, %	18.8	15.0	12.5	23.0	20.0	18.0
Ca, %	4.06	3.25	2.71	1.00	0.90	0.80
P[c], %	0.31	0.25	0.21	0.45	0.35	0.30
Potassium, %	0.19	0.15	0.13	0.30	0.30	0.30
Copper, mg	?	?	?	8	8	8
Zinc, mg	44	35	29	40	40	40
Sodium, %	0.19	0.15	0.13	0.20	0.15	0.12

a Grams feed intake/hen daily
b Based on dietary metabolizable energy concentration of approximately 2,900 kcal/kg (1,318 kcal/lb) and an assumed 90% egg production rate (90 eggs daily per 100 hens).
c Phosphorus is nPP.
1Adapted from Tables 2-3, 2-6, 3-1, 5-1. *Nutrient Requirements of Poultry*, 9th Revised Edition, 1994. National Research Council.

Nutrition: The Easy Way to Reduce Waste?

- Under field conditions, animals use n… mediocre efficiency:
  - N: 30% to 35%
  - P: 30%
- Under l…ons:
  - …P: close to 100%

There is a lot of potential for reducing waste and improving efficacy

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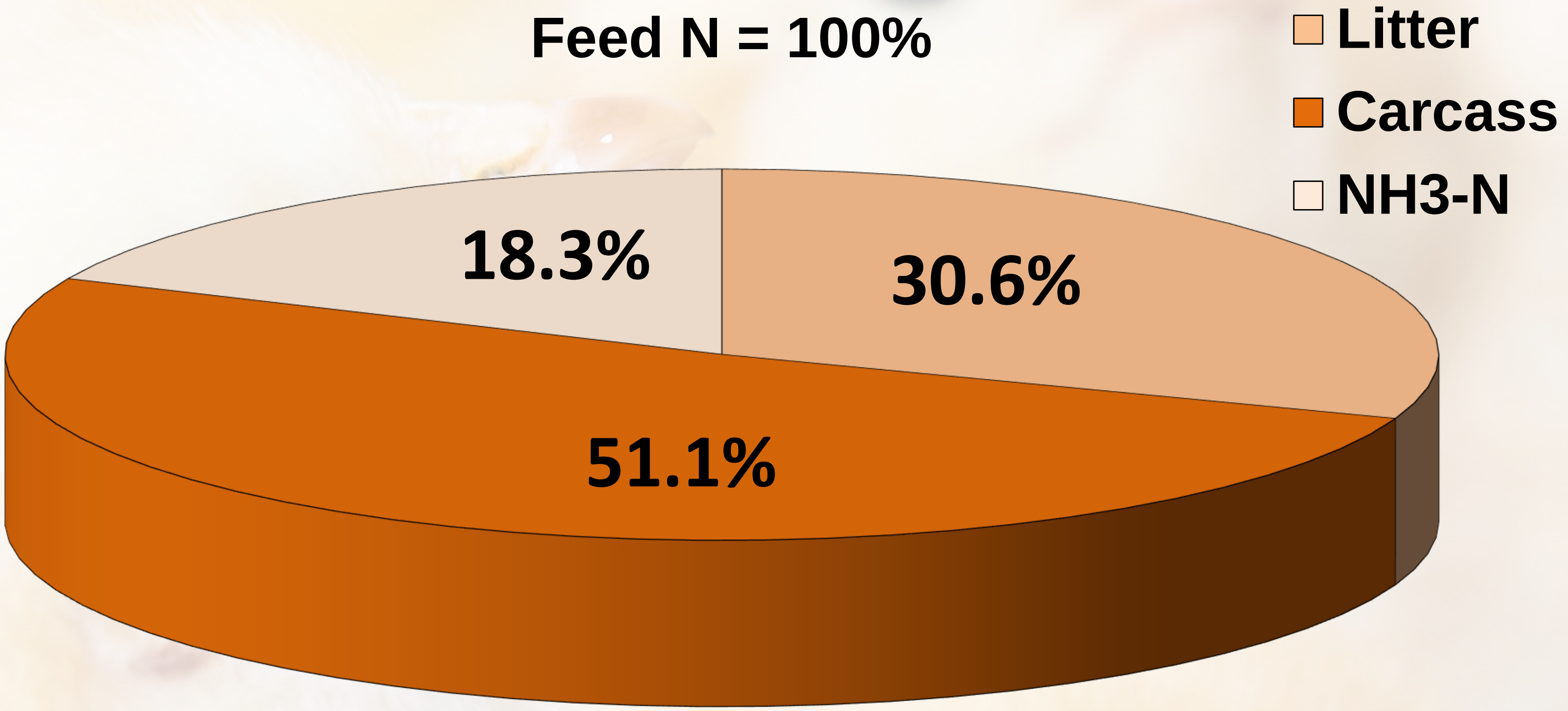
Tracking N in Broilers



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Low Protein Diet: Utilize “True AA Digestibility.”

- Formulating based on AA rather than CP can lower N content by lowering dietary N input.

- Utilizing AAs, such as methionine and lysine, reduces dietary protein from 18% to 16% and reduces the cost of the diet by more than $4/ton.

- Diets should be based on the digestible fraction rather than simply the amount of AAs present in the feed.

- Calculated digestible AA requirements can be 8%-10% lower than total AA requirements.

Meat Meal Variation

AA	A	B	C	Mean	CV %
Met	0.61	0.41	0.49	0.50	20.13
Cys	0.70	0.30	0.39	0.46	45.62
Lys	2.77	1.93	1.94	2.21	21.82
Thr	1.73	1.12	1.25	1.37	23.45
Arg	3.62	3.00	2.90	3.17	12.3

- ❑ Variability in the nutrient values of common feeds leads nutritionists to add a margin of safety, ensuring that nutritional needs are met.
- ❑ Rapid ingredient analysis techniques, such as NIR, provide real-time information on the feed's nutritional value.
- ❑ This information reduces the need for over-formulation as a safety margin.

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Trace mineral recommendations for poultry

Trace mineral recommendations

Minerals	NRC (Broilers)	NRC (Layers)	NRC (Breeders)	Cobb	Ross	Hubbard	HyLine[1,2]	ISA- Brown	Industry
Zn	40	35			3.5X			60	100-160
Cu	8	?			2.5X			1	16-20
Mn	60	20			2.0X			70	100-120
Fe	80	45			1.5X			60	80-90

[1]Minimum recommendations for growing and laying periods. Local regulations may limit the dietary content of individual trace minerals.
[2]20% of Manganese or Zinc may be in organic form.

Alltech MINERAL MANAGEMENT

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The manure mineral level in breeders

(Malaysia trial, 2012)

	Feed (ppm)			[illegible]		
	Inorganic	Organic*	% Diff**	[illegible]	[illegible]	[illegible]
Manganese	87.5	40	[illegible]	[illegible]	[illegible]	-38%
Zinc	[illegible]	[illegible]	[illegible]	[illegible]	236	-31%
Copper	[illegible]	[illegible]	[illegible]	48	25	-48%
[illegible]	[illegible]	15	-80%	594	583	-2%
[illegible]	0.31	0.3	-	2.93	1.87	-36%

‘Precision’ formulating will increase efficacy, improve profitability, and reduce waste

*Organic mineral (proteinates) is total replaced at 1Kg/tonne of breeder feed

* *% of reduction compared to inorganic mineral group

BROILERS

Global meta-analysis and sustainability impacts of supplementing **Proteinates** organic minerals in broilers

Meta-analysis methodology

	Literature search	Study selection	Data extraction	Calculations and statistical analysis
PERFORMANCE DATABASE	**Over 100** research trials reviewed	**14 studies** conducted in **50,032 broilers**	**157** IOTM diets *vs.* ***Proteinates*** diets	Comprehensive meta-analysis statistical software
EXCRETION DATABASE		**9 studies** conducted in **21,532 broilers**	**64** IOTM diets *vs.* ***Proteinates*** diets	

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Average dosage of trace minerals supplemented

	Broiler performance database			Mineral excretion database		
TM (mg/kg diet)	**Inorganic**	**Organic**	**Relative difference**	**Inorganic**	**Organic**	**Relative difference**
Zinc	63.77	39.43	**- 38%**	61.41	36.35	**- 41%**
Manganese	80.42	46.57	**- 42%**	71.85	41.10	**- 43%**
Copper	12.66	8.48	**- 33%**	12.70	8.72	**- 31%**
Iron	45.42	22.84	**- 50%**	37.85	19.72	**- 48%**

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Comparisons of mineral dosages in the meta-analysis database and the NRC requirements

TM (mg/kg diet)	NRC	Inorganic	Variance	Organic	Variance
Zinc	40	64	+60%	39	-3%
Manganese	60	80	+33%	47	-22%
Copper	8	13	+63%	8	0%
Iron	80	45	-44%	23	-71%

- **Inorganic Zn, Mn and Cu are supplemented above requirements**

Impact of feeding **Organic proteinates** to broilers

Feed use/weight gain
-0.1

Mortality
-0.7%

Daily feed intake
-1 g/bird

Average daily gain
+1 g/day

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Impact of feeding **Organic proteinates** to broilers on mineral excretion

Zinc excretion	Copper excretion	Manganese excretion	Iron excretion
-13%	**-14%**	**-18%**	**-12%**
Zn	Cu	Mn	Fe

Organic proteinates minerals reduced the excretion of trace minerals in broilers.

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Carbon footprint

THE GLOBAL GOALS
For Sustainable Development

13 CLIMATE ACTION

BIOPLEX®

1,000,000

1 fewer day to slaughter

2.5% reduction in emission intensity (-70 g CO_2e/kg liveweight)

23% mortality reduction

CO_2

-171 tonnes CO_2e

=

112 fewer cars on the road

199 transatlantic return flights

115 houses' use of electricity

Alltech® E-CO_2

INCREASING YOUR PROFIT AND PROTECTING THE ENVIRONMENT

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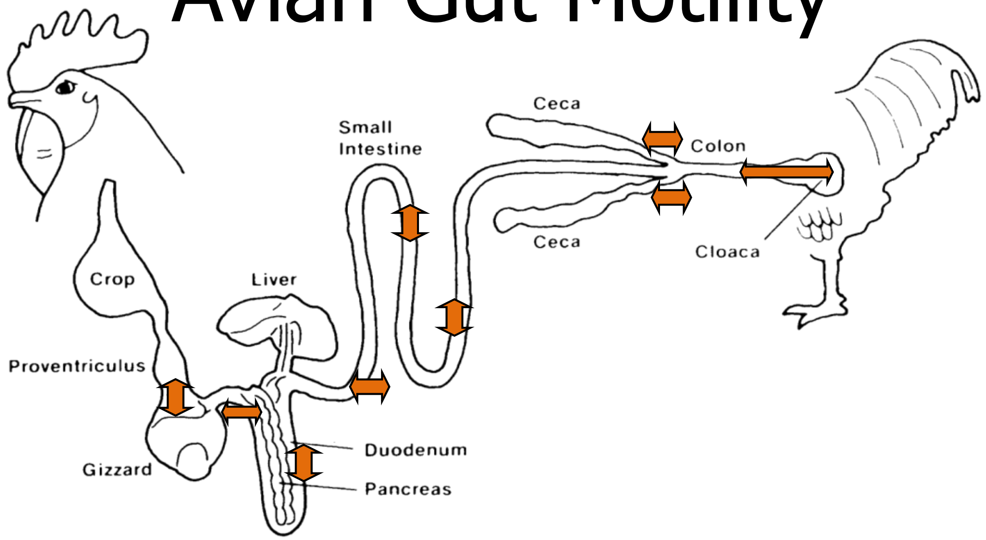
Areas to consider….

- ✓ **Diet adjustments**
  - ➢ Improving efficacy & reducing waste
- ✓ **Manufacturing practices**
  - ➢ Testing, precision, new approaches
- ✓ **Scientific advancements**
  - ➢ Alternative feed ingredients, Gut health, Nutrigenomics, equipment, etc.
- ✓ **Alternative programs to meet consumer demands**
  - ➢ Food quality concerns

Processing can Improve Nutrient Digestibility.

- Grinding:
  - Grind feed to uniform particle size.
- Pelleting:
  - Improves protein digestibility 3.7%.

Avian Gut Motility



Gizzard Is the Pace-Setter of Motility Necessary For Normal Enteric Ecosystem

Effect of Coarse-Ground Corn in Pelleted Diets on Broilers

Performance Measurement	0% CC[1]	50% CC[2]
42 d Body Weight, g	2,929[b]	3,059[a]
1-42 d FCR	1.94[a]	1.82[b]
Gizzard : Proventriculus Weight Ratio	**2.11[b]**	**3.44[a]**
Gizzard Digesta pH	4.67[a]	4.1[b]
Gut Retention Time of Digesta, minutes	212	265
% Dietary Nitrogen Retention	**74.0[b]**	**76.5[a]**
% Dietary Energy Digestibility	**61.9[b]**	**66.1[a]**
% Litter Moisture at 42 days of age	36.0	29.0

(D_{gw})= mean particle size

(S_{gw})= particle size standard deviation

[1]0% CC = all corn 350 Dgw, 3.0 Sgw

[2]50% CC = 50% of dietary corn ground to 970 Dgw, 3.7 Sgw

(Yi et al., 2014)

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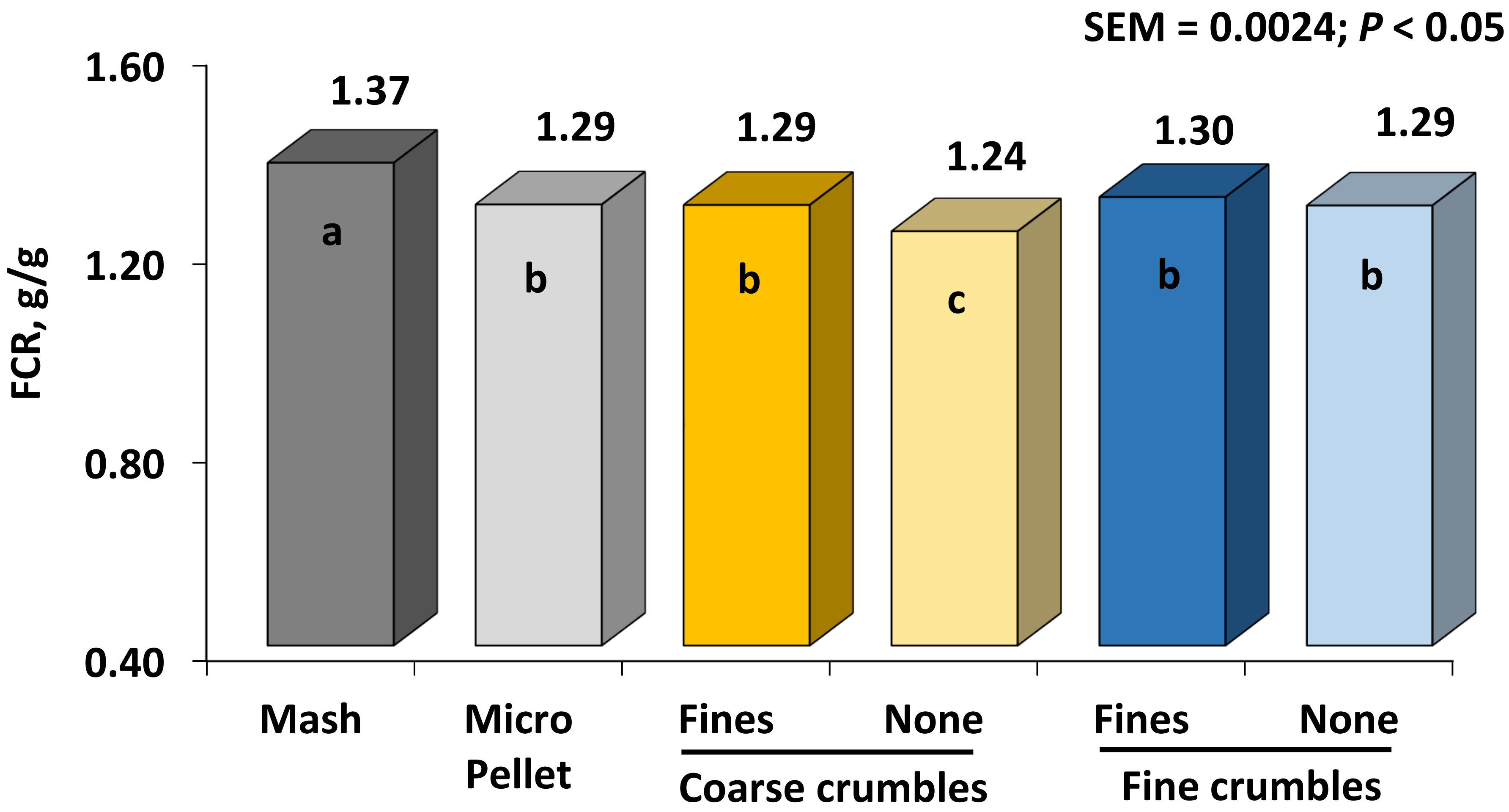
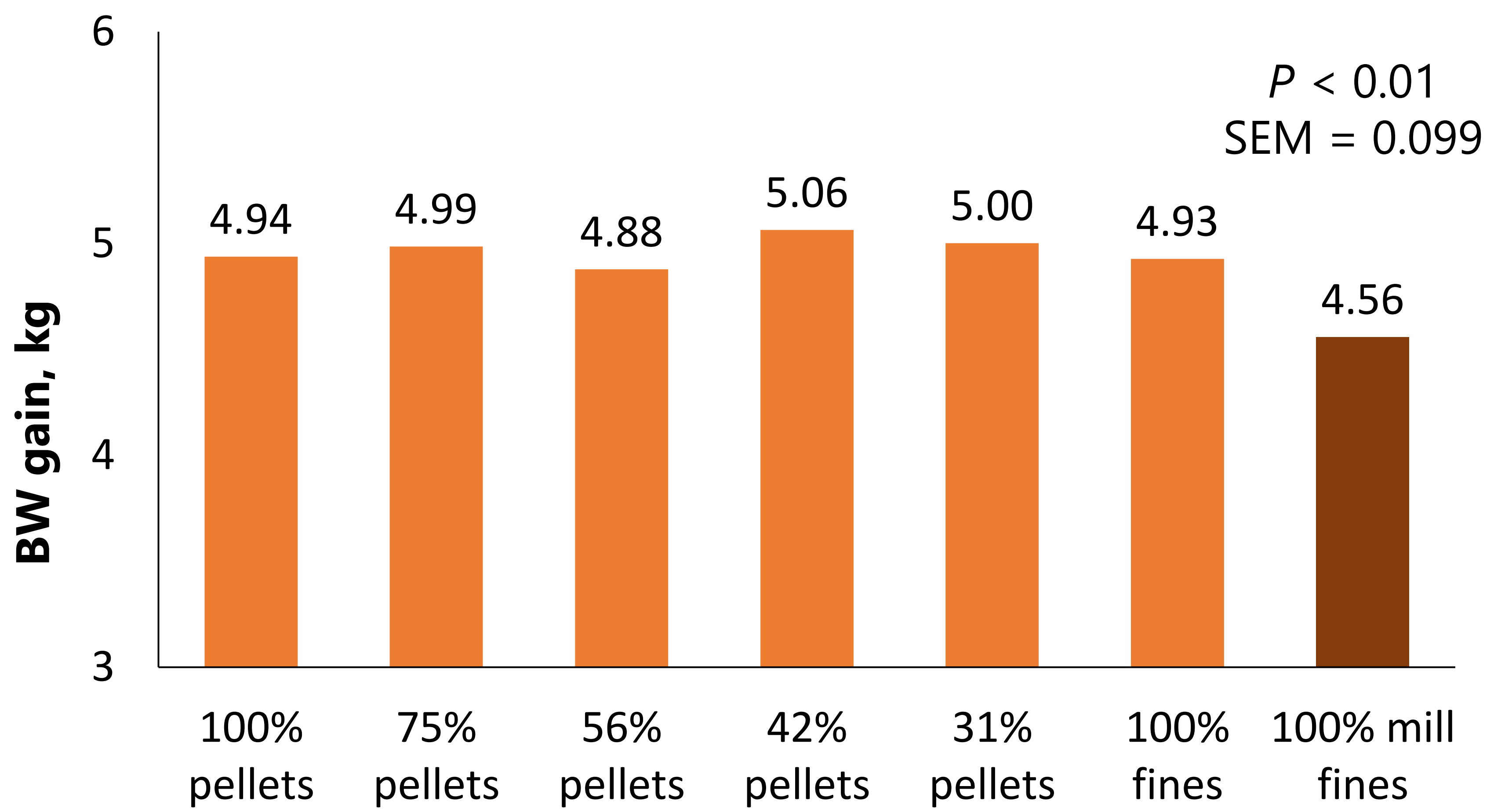
Feed Conversion – 21 d



Idan, 2019

Pellet Fines on Broilers Performance



McCafferty et al., 2023

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Feed costs represent the biggest input for producers, often accounting for **UP TO 70% OF PRODUCTION COSTS.**

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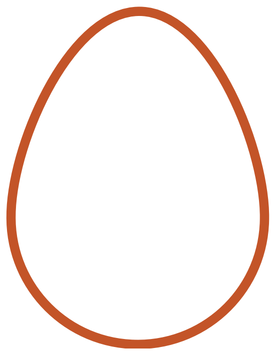
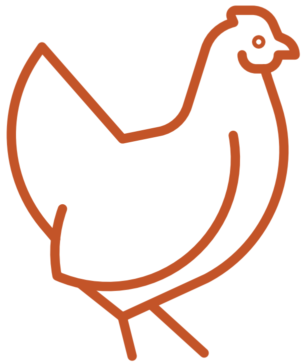
For every $10 change in the price of SBM per ton:

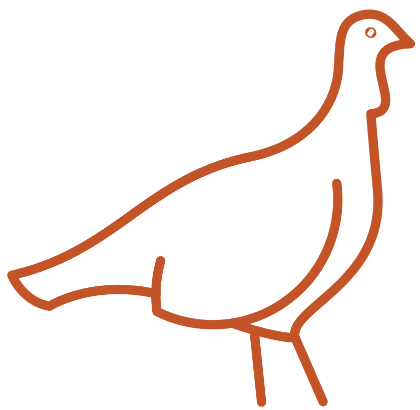
The cost of poultry production increases by



$0.44 cents per dozen of eggs.



$0.24 cents per pound liveweight in broilers.



$0.32 cents per pound liveweight in turkeys.

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How Can We Capture More Value from Feedstuffs?

Can We Use More High-Fiber Co-Products?

Can We Lower Costs and Maintain Gut Health?

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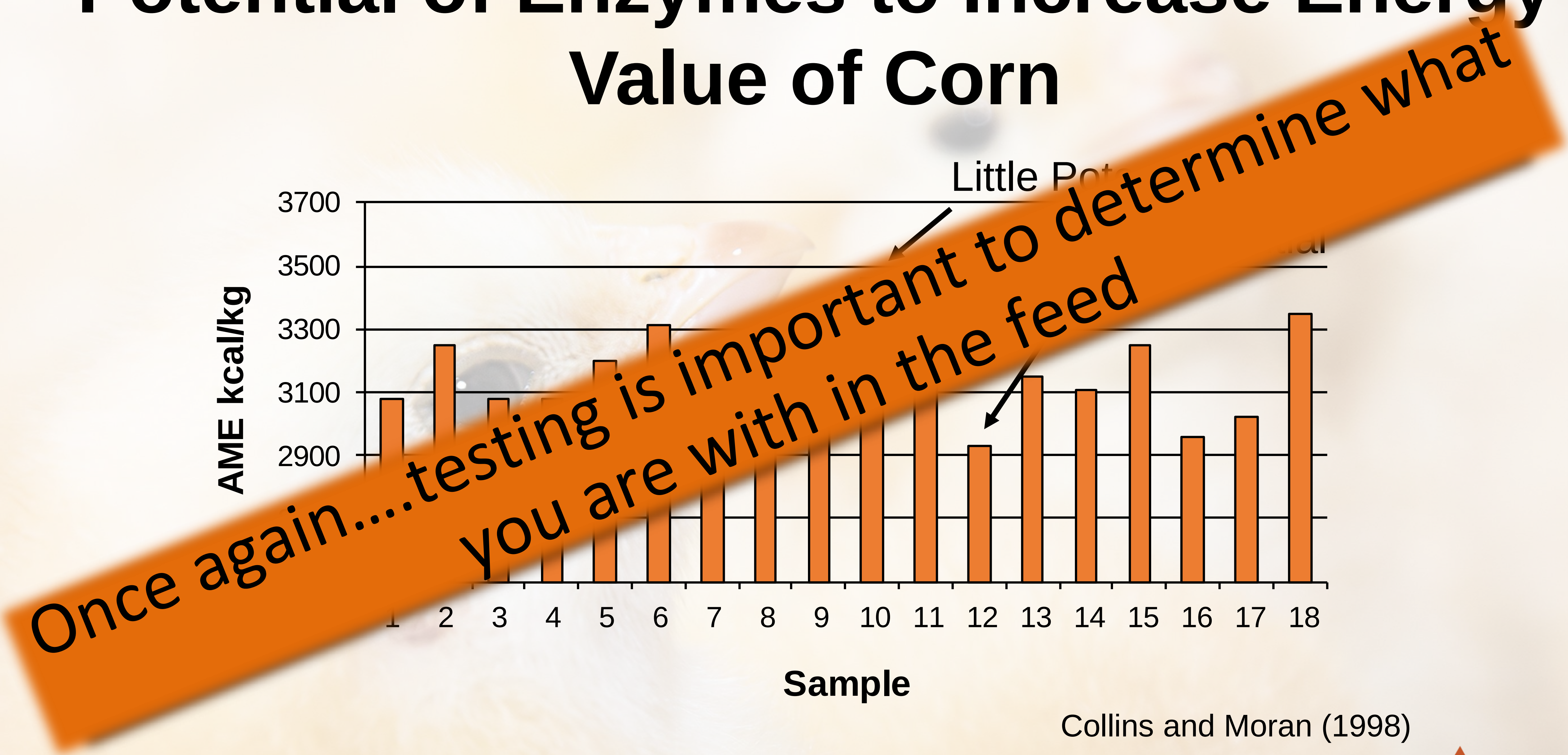
Potential of Enzymes to Increase Energy Value of Corn



Collins and Moran (1998)

Enzymes used in poultry diets

ENZYMES	SUBSTRATES	INGREDIENTS
Phytase	Phytate	Plant-based ingredients
Xylanase	Arabinoxylans (NSP)	Wheat, rye
β-glucanase	β-glucans (NSP)	Barley, oats
Pectinase	Pectins (NSP)	Lupins & vegetable meals
α-galactosidases	Oligo-saccharides	Vegetable meals
β-mannanase	Mannans	Vegetable meals
Protease	Protein	Corn, vegetable meals
Amylase	Starch	Corn, rice, wheat, sorghum

Solid State Fermentation Enzyme

META-ANALYSIS

BROILERS:

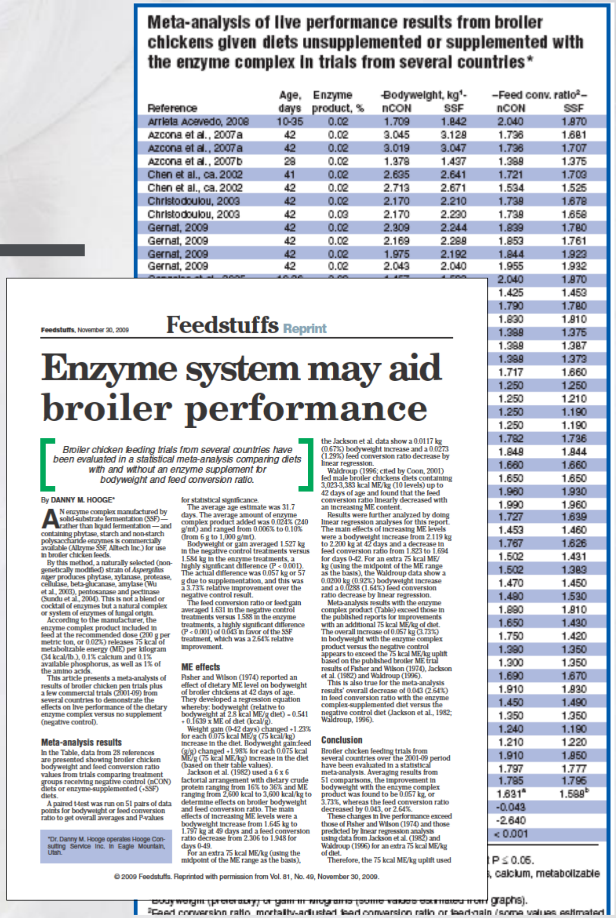
3.73% more live weight

2.64% better feed conversion

LAYERS:

3.47% more egg mass

3.09% less feed intake



Meta-analysis of live performance results from broiler chickens given diets unsupplemented or supplemented with the enzyme complex in trials from several countries*

Reference	Age, days	Enzyme product, %	–Bodyweight, kg[1]– nCON	SSF	–Feed conv. ratio[2]– nCON	SSF
Arriela Acevedo, 2008	10-35	0.02	1.709	1.842	2.040	1.870
Azcona et al., 2007a	42	0.02	3.045	3.128	1.736	1.681
Azcona et al., 2007a	42	0.02	3.019	3.047	1.736	1.707
Azcona et al., 2007b	28	0.02	1.378	1.437	1.388	1.375
Chen et al., ca. 2002	41	0.02	2.635	2.641	1.721	1.703
Chen et al., ca. 2002	42	0.02	2.713	2.671	1.534	1.525
Christodoulou, 2003	42	0.02	2.170	2.210	1.738	1.678
Christodoulou, 2003	42	0.03	2.170	2.230	1.738	1.658
Gernat, 2009	42	0.02	2.309	2.244	1.839	1.780
Gernat, 2009	42	0.02	2.169	2.288	1.853	1.761
Gernat, 2009	42	0.02	1.975	2.192	1.844	1.923
Gernat, 2009	42	0.02	2.043	2.040	1.955	1.932

Feedstuffs, November 30, 2009 — Feedstuffs Reprint

Enzyme system may aid broiler performance

Broiler chicken feeding trials from several countries have been evaluated in a statistical meta-analysis comparing diets with and without an enzyme supplement for bodyweight and feed conversion ratio.

By DANNY M. HOOGE*

117 trials in poultry, including **68** broiler, **42** layer

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Enzymes **reduce** the carbon footprint

Overall emissions improvements amongst different enzyme technologies

What does this mean for a one million bird production system?

Emissions reduction	Phytase only	Allzyme Vegpro	Allzyme SSF	Allzyme Spectrum
Tons CO_2e saved from baseline	25.9	447.9	515.8	660.3
Trans Atlantic flights (LHR - JFK)	-30	-521	-600	-767
Cars off road (UK)	-17	-293	-337	-431

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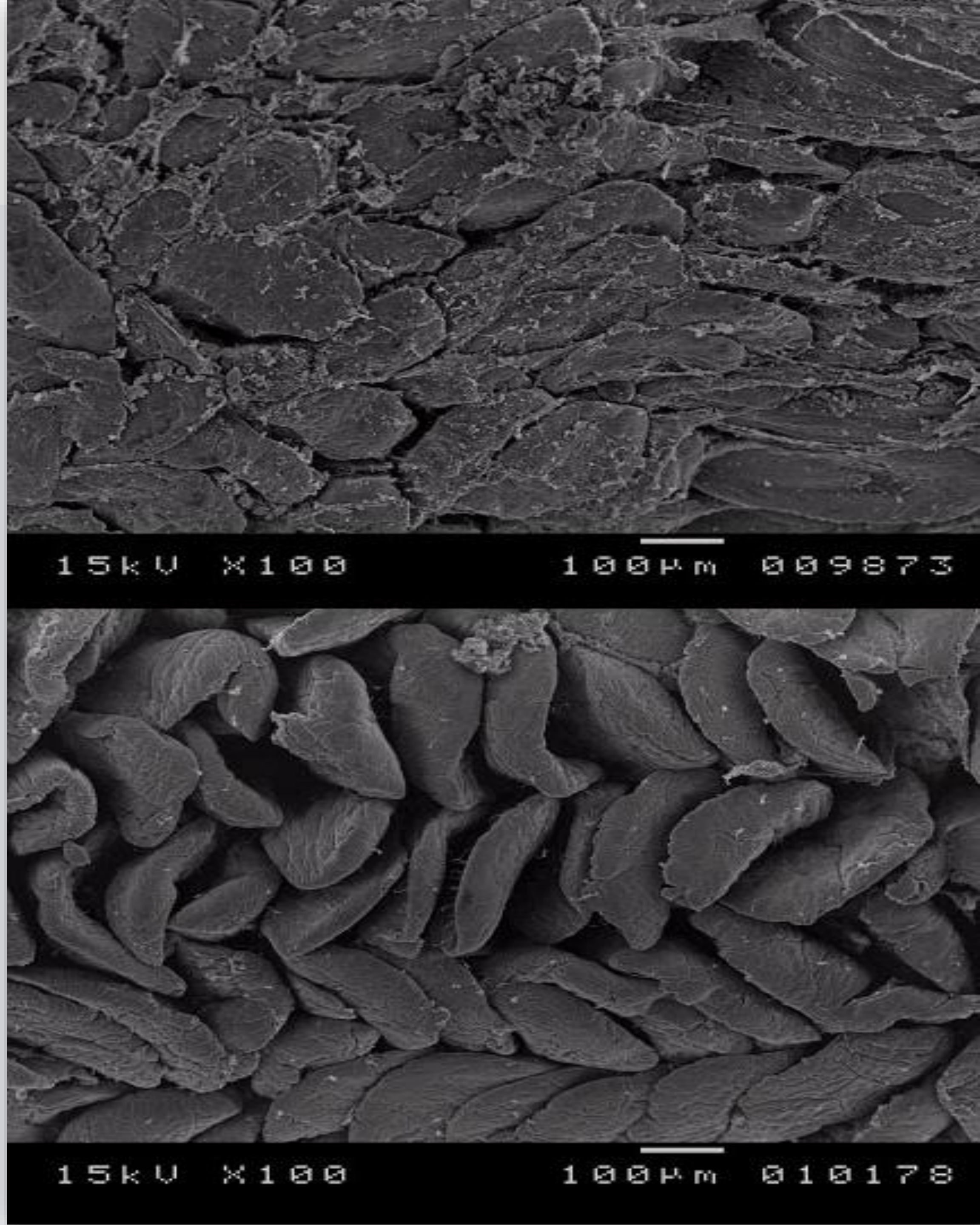
Healthy Gut =
Healthy Animal

"Improved gut integrity: This difference explains the more efficient feed conversion."

- Loddi et al., 2002



Gut health &
Immunity

- **90%** of diseases can be traced back to gut health and the microbiome
- **70%** of the immune system functions through the gut tissue
- **30%** of energy requirements are by the gut

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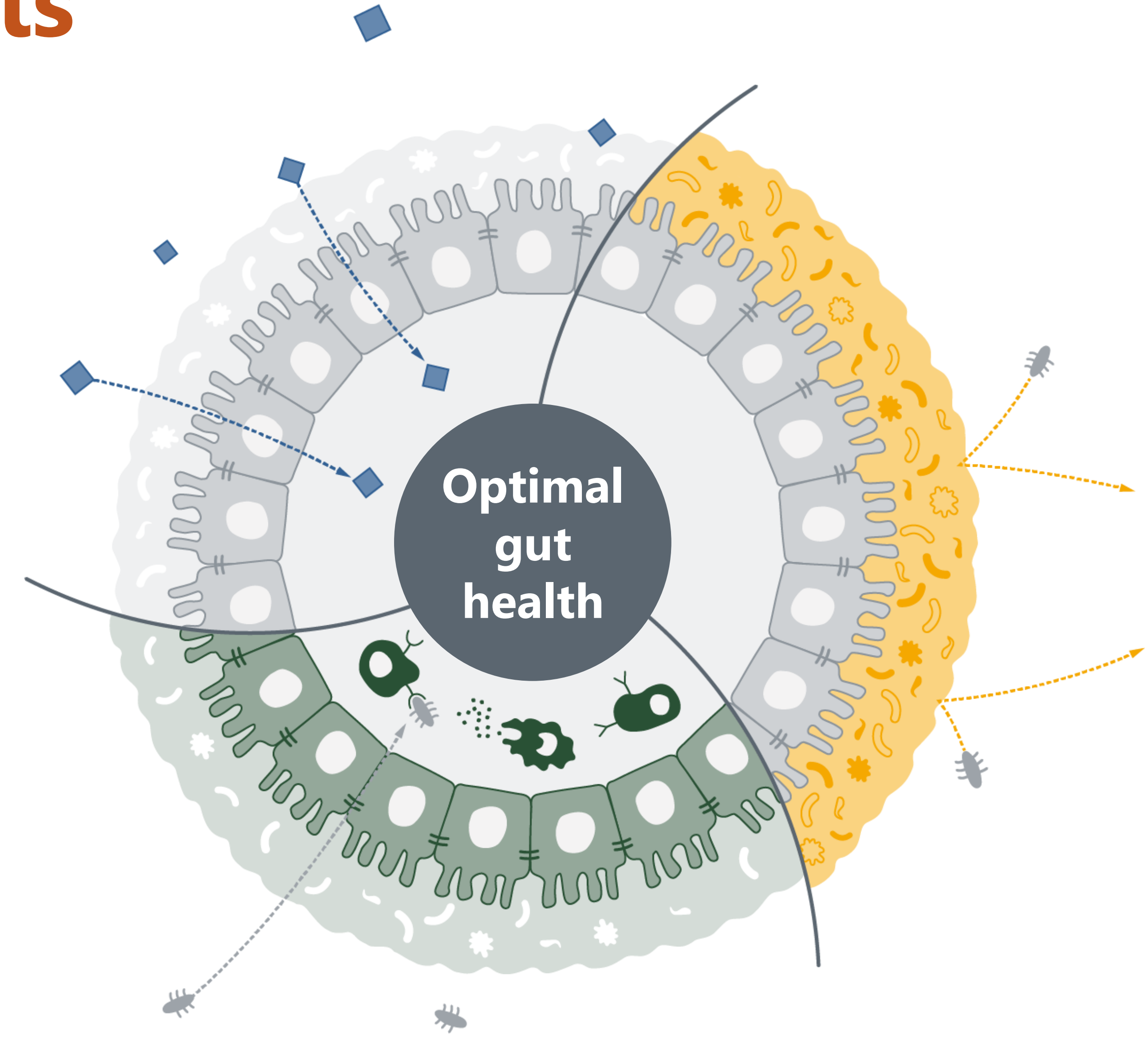
The 3 defining elements for optimal gut health

Nutrient absorption
for improved performance

Microbial diversity
for better welfare and safer food

Strong immunity
for building natural defences



12 feed antibiotic reduction lessons from EU producers

- Cost increases are inevitable
- Profitability will fund cost increases
- Performance level will never be the same
- Variability in performance will increase
- Farm health status must be increased
- Immunity should be boosted at any cost
- Feed formulations cannot remain the same
- No single additive can replace antibiotics
- Additive combinations are required
- Farm personnel must be re-educated
- The veterinarian must have the first word
- A qualified nutritionist must be employed

Feed Strategy, 2019 Jan p36-38

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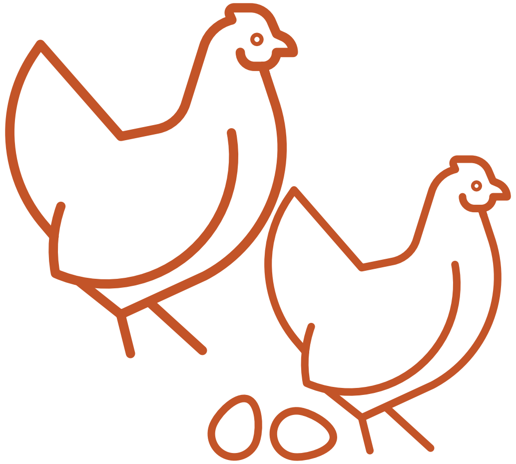
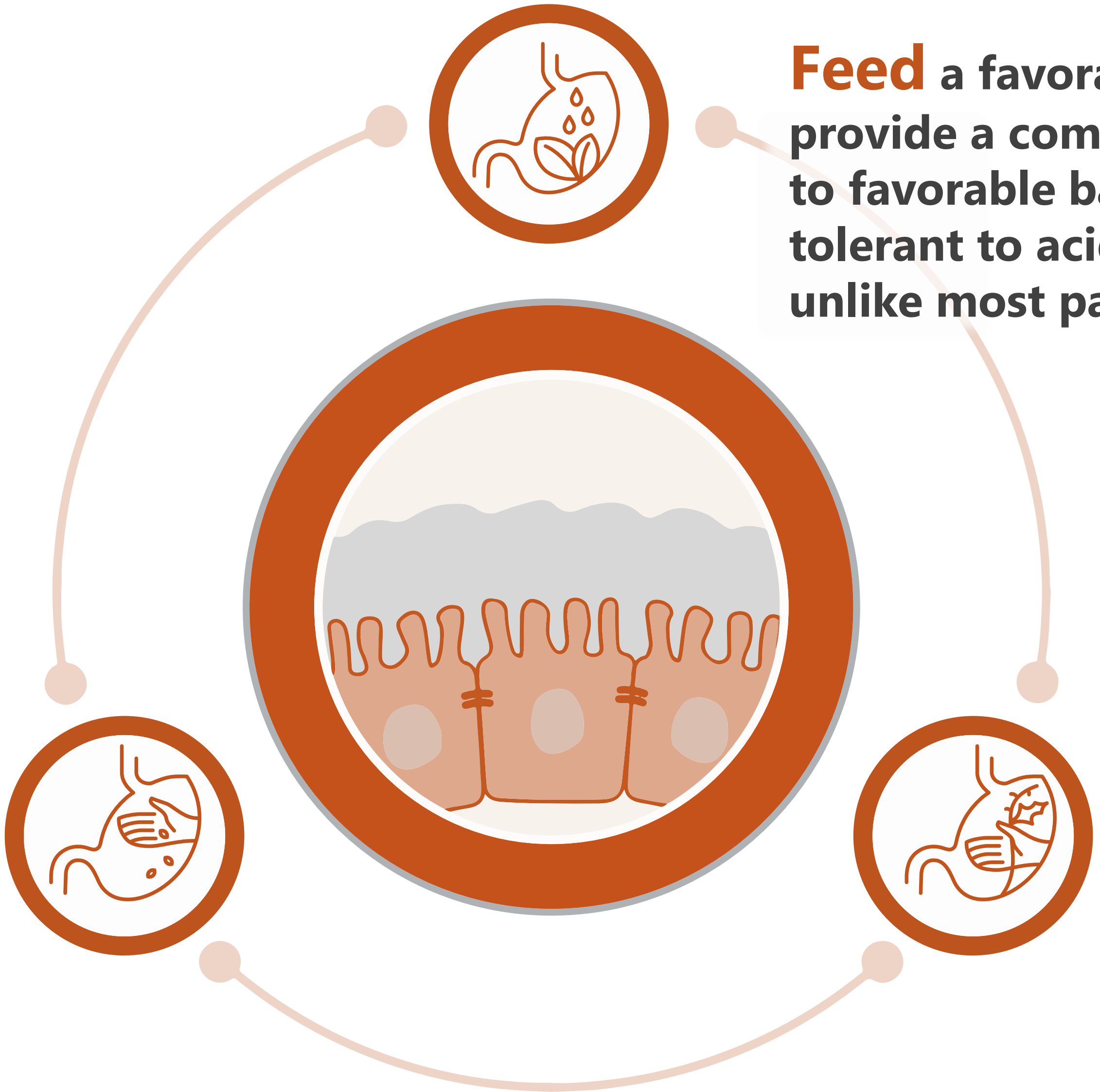




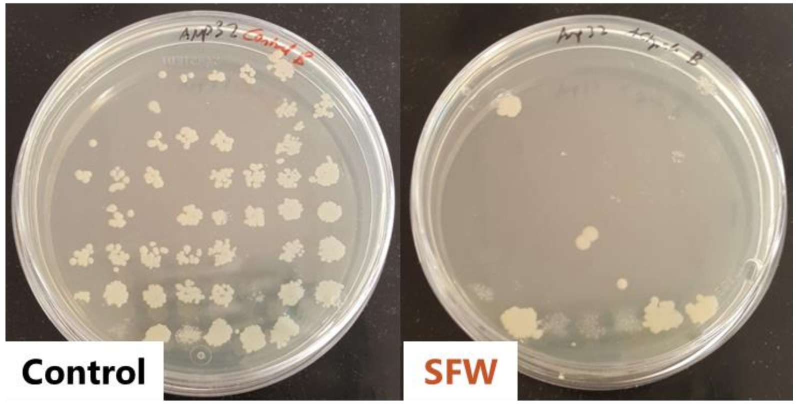
Feed a favorable environment to provide a competitive advantage to favorable bacteria, which are tolerant to acidic environments, unlike most pathogens

Seed the gut with favorable organisms for improved performance in young animals

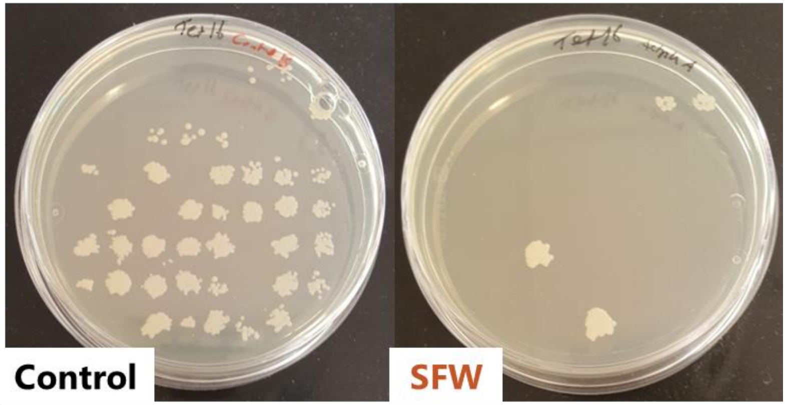
Weed out unfavorable bacteria by selective exclusion

Reducing the prevalence of AMR with SFW

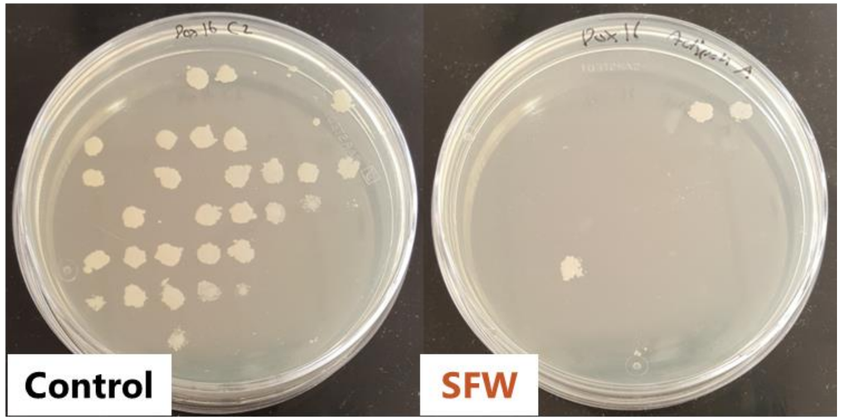
Ampicillin



Tetracycline



Doxycycline



- SFW reduced the growth of bacteria resistant to antibiotics
- SFW enhanced antibiotic efficiency
- Less antibiotic use
- Less transmission of resistance

SFW layer performance data– meta analysis

Improve hen-day production by 4.5% (egg)

Reduce mortality of laying hens by 2.39%

Reduce feed use/kg eggs produced by 134g

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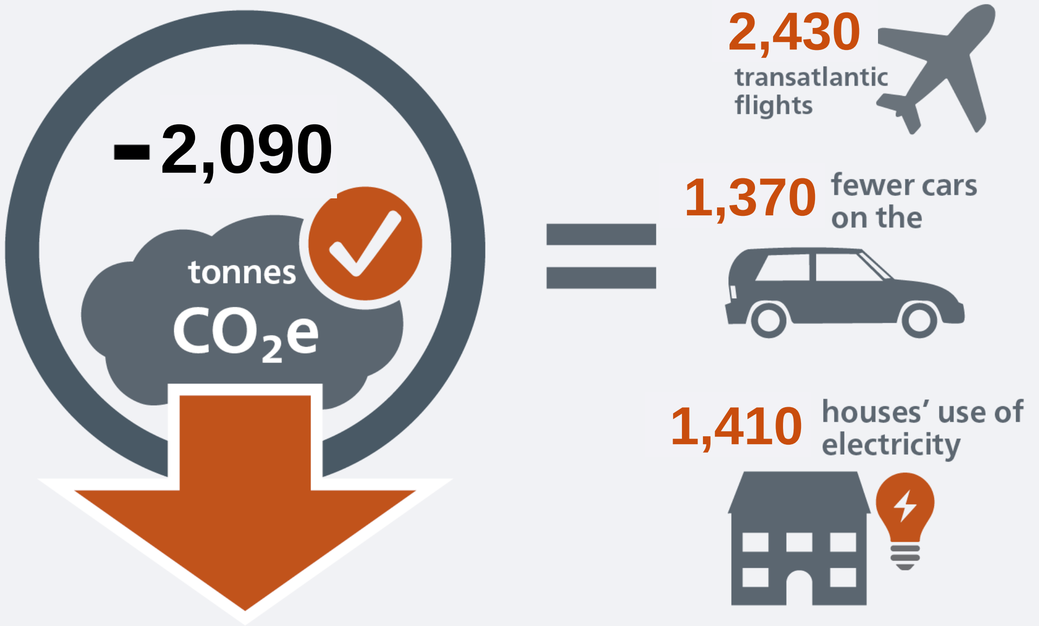
Carbon reduction

SFW decreases greenhouse gas emissions by an average of

5.5%



Impact on 1 million layer flock per laying cycle

Areas to consider….

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  - ➢ Food quality concerns

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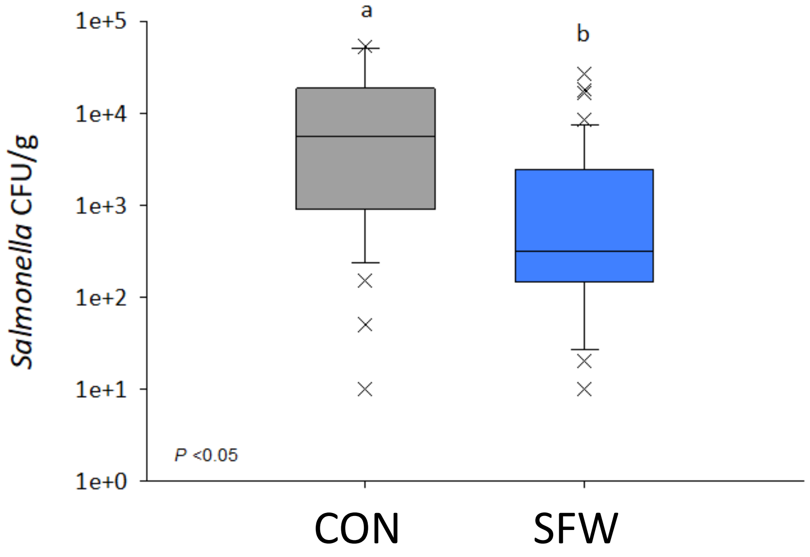
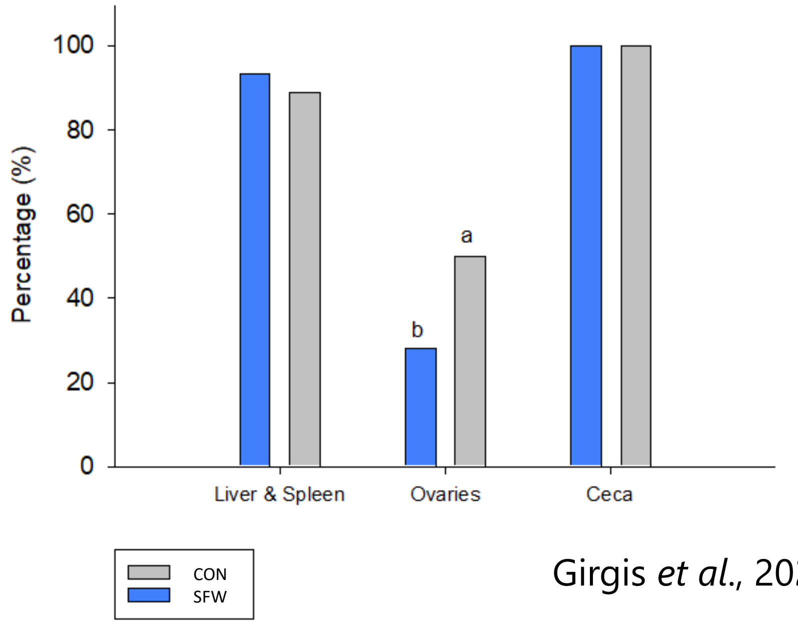
Salmonella control **with SFW**

Food safety

MRF reduces 1 log of *Salmonella* in cecal contents

APPROVED
feed additive for fresh shell egg suppliers listed in Walmart's Best-in-Class Program





Girgis *et al.*, 2020

Reduce the pathogen colonization → **Stop the invasion process** → **Better food safety implication**

Food safety

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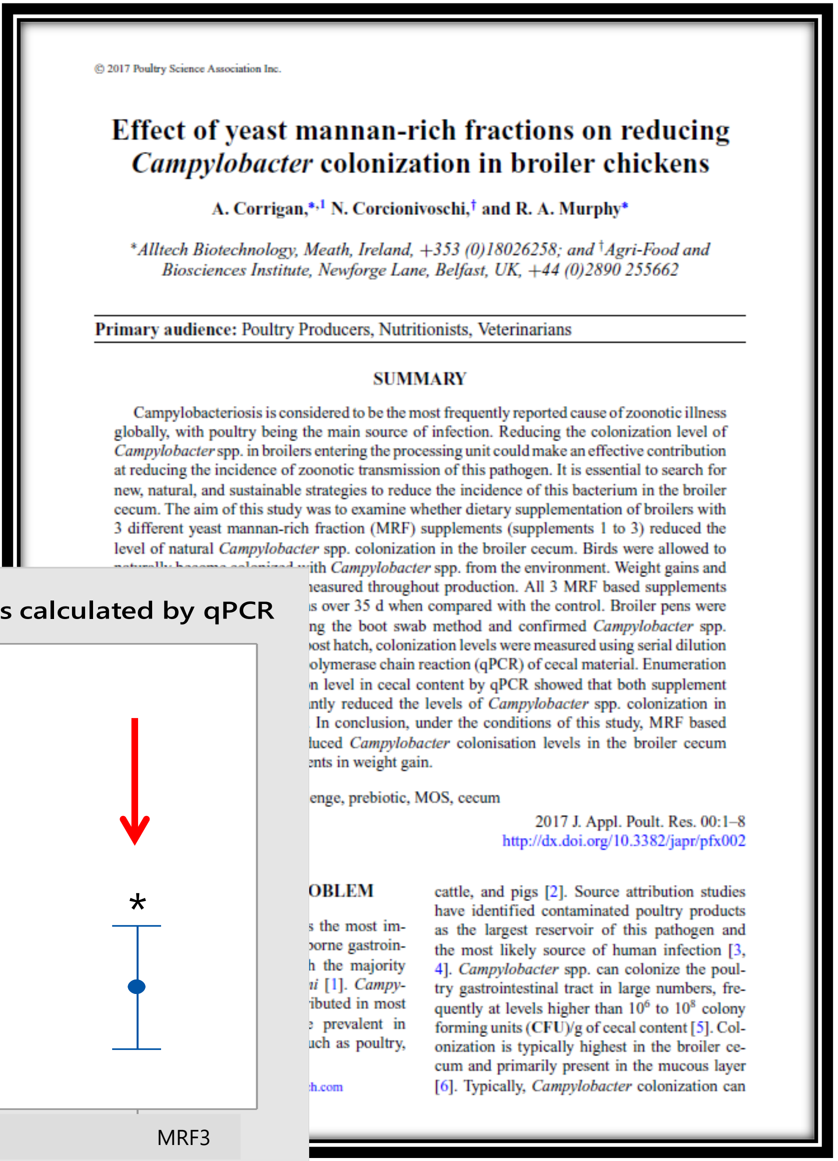
Campylobacter control with SFW

- Campylobacter colonisation reduced at day 35
- Better food safety implication
- > 1.5 log CFU reduction

- Reduced Campylobacter colonization
- Improved weight gain



Effect of yeast mannan-rich fractions on reducing *Campylobacter* colonization in broiler chickens

A. Corrigan,*[,1] N. Corcionivoschi,[†] and R. A. Murphy*

*Alltech Biotechnology, Meath, Ireland, +353 (0)18026258; and [†]Agri-Food and Biosciences Institute, Newforge Lane, Belfast, UK, +44 (0)2890 255662

Primary audience: Poultry Producers, Nutritionists, Veterinarians

SUMMARY

Campylobacteriosis is considered to be the most frequently reported cause of zoonotic illness globally, with poultry being the main source of infection. Reducing the colonization level of *Campylobacter* spp. in broilers entering the processing unit could make an effective contribution at reducing the incidence of zoonotic transmission of this pathogen. It is essential to search for new, natural, and sustainable strategies to reduce the incidence of this bacterium in the broiler cecum. The aim of this study was to examine whether dietary supplementation of broilers with 3 different yeast mannan-rich fraction (MRF) supplements (supplements 1 to 3) reduced the level of natural *Campylobacter* spp. colonization in the broiler cecum. Birds were allowed to

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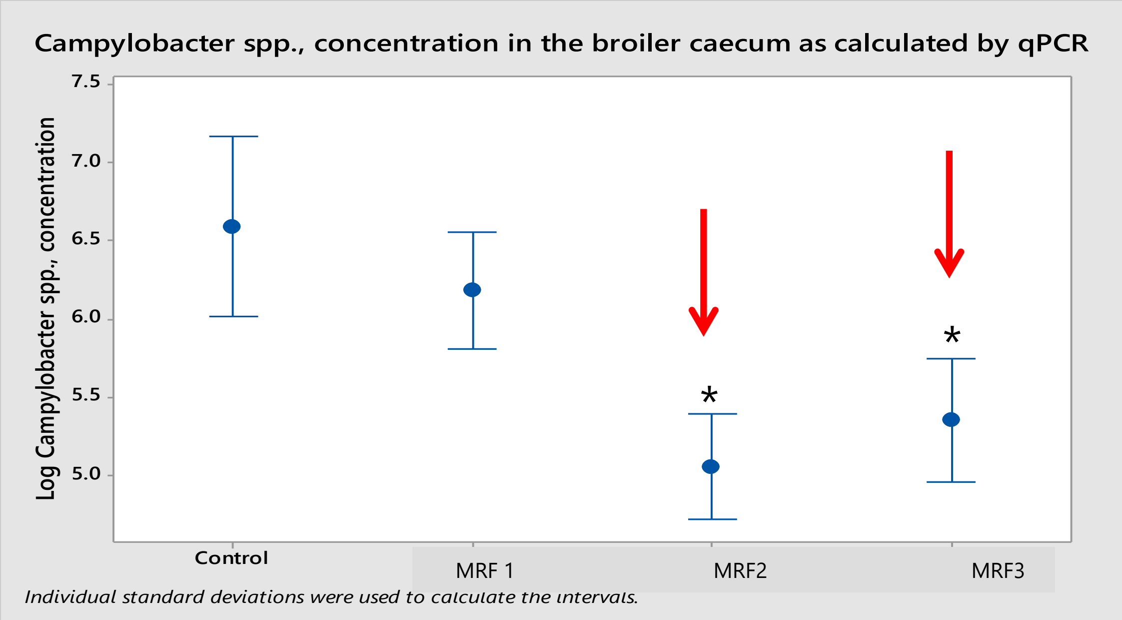
cattle, and pigs [2]. Source attribution studies have identified contaminated poultry products as the largest reservoir of this pathogen and the most likely source of human infection [3, 4]. *Campylobacter* spp. can colonize the poultry gastrointestinal tract in large numbers, frequently at levels higher than 10^6 to 10^8 colony forming units (CFU)/g of cecal content [5]. Colonization is typically highest in the broiler cecum and primarily present in the mucous layer [6]. Typically, *Campylobacter* colonization can



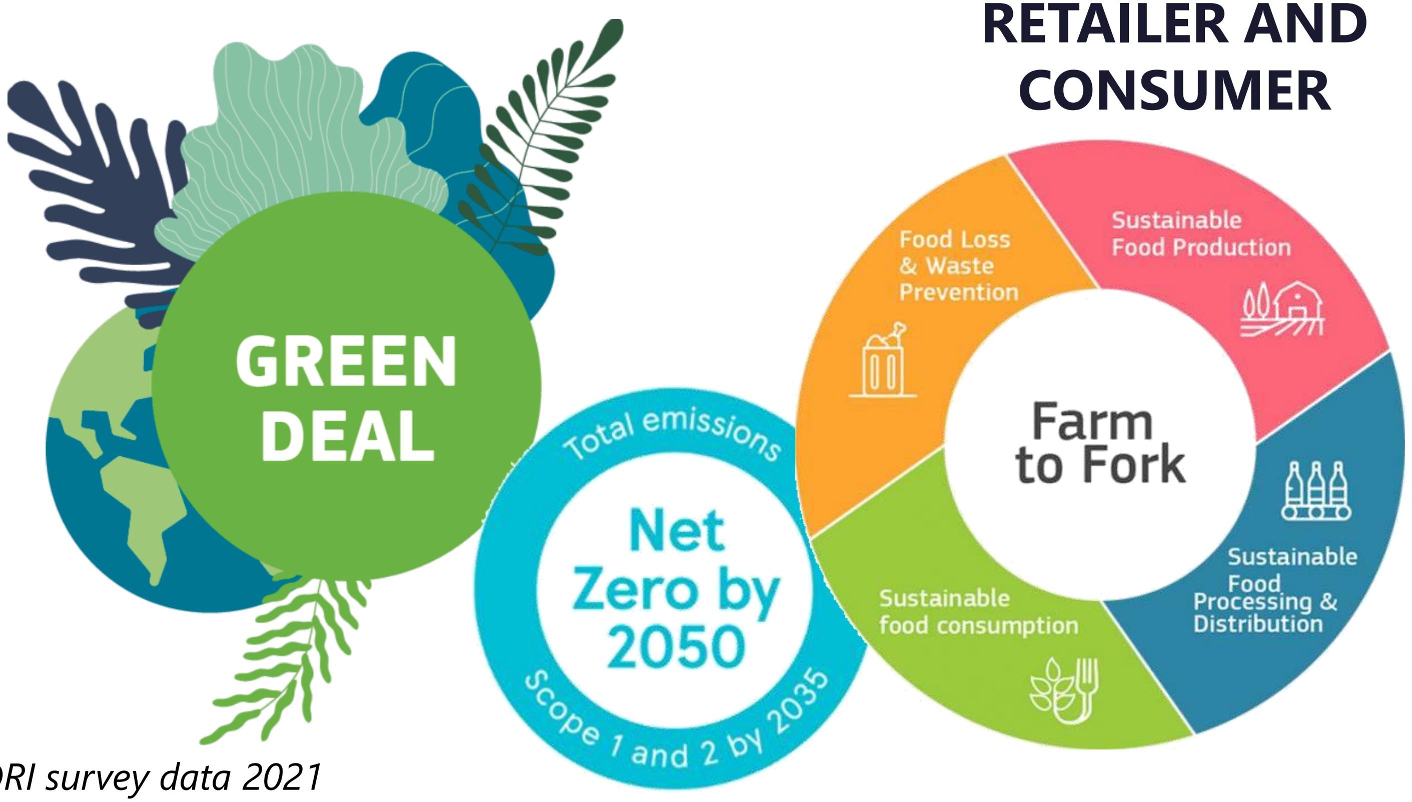
* Significantly reduced compared to the control, $p<0.001$

Enviro-Egg Pack Case

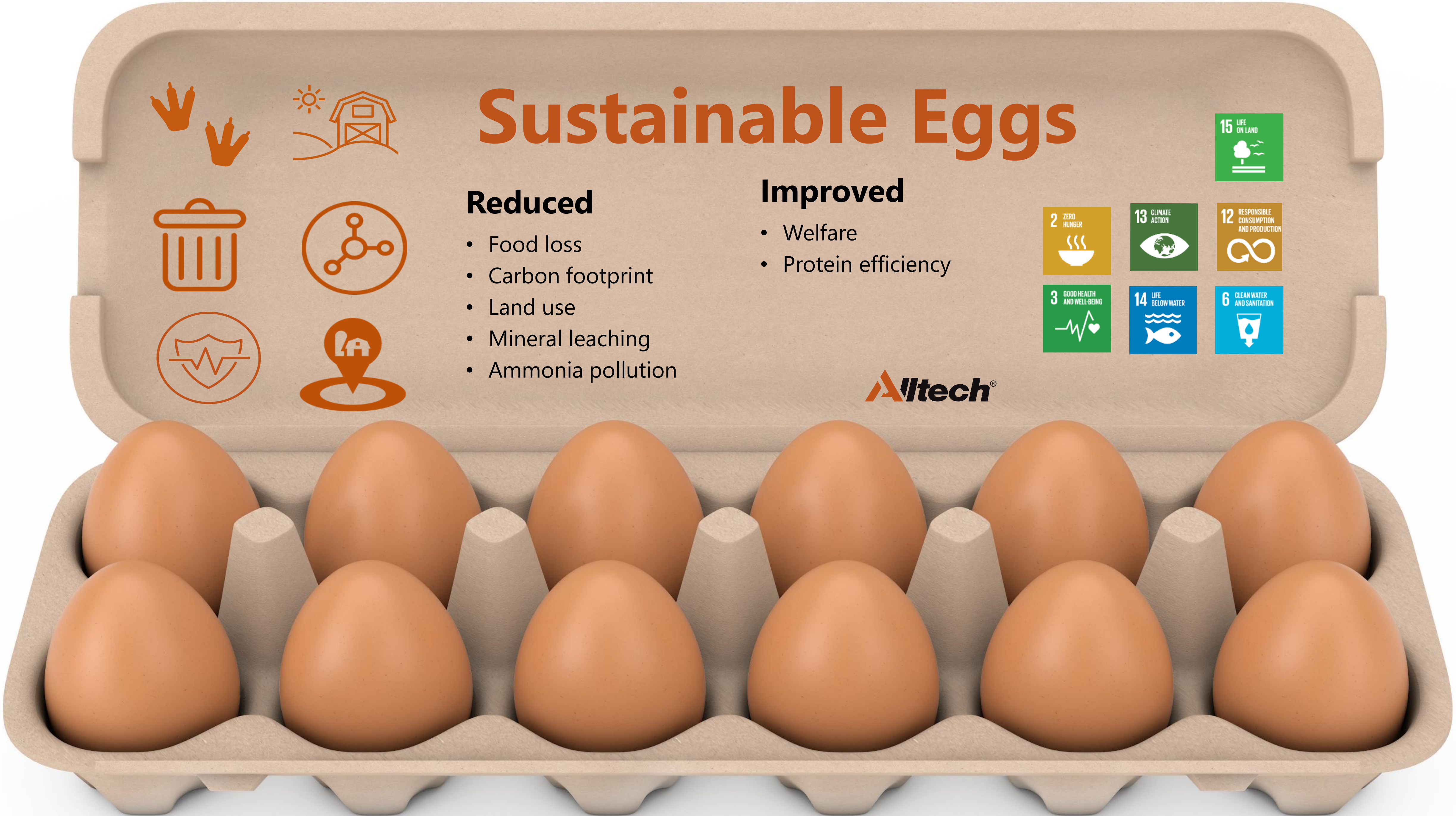
73%

of consumers*

think it is important for them to buy food that has a low environmental impact



**Source: Food Standards Agency (FSA) with Ipsos MORI survey data 2021*


Sustainable Eggs
Reduced
• Food loss
• Carbon footprint
• Land use
• Mineral leaching
• Ammonia pollution
Improved
• Welfare
• Protein efficiency
15 LIFE ON LAND
2 ZERO HUNGER
13 CLIMATE ACTION
12 RESPONSIBLE CONSUMPTION AND PRODUCTION
3 GOOD HEALTH AND WELL-BEING
14 LIFE BELOW WATER
6 CLEAN WATER AND SANITATION
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